

Surface Longwave Radiative Fluxes (LRF) comparisons between Surface Radiative Budget (SRB) and the CALIPSO-CloudSat-CERES- MODIS (CCCCM{C3M}) during 2006-2007

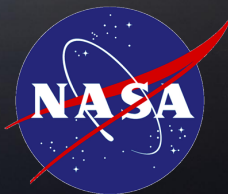
Fall CERES Science Team Meeting

October 4-6, 2011

Lawrence Livermore National Laboratory (LLNL)

Livermore, CA

Antonio Viudez-Mora, PhD



NASA Langley Research Center

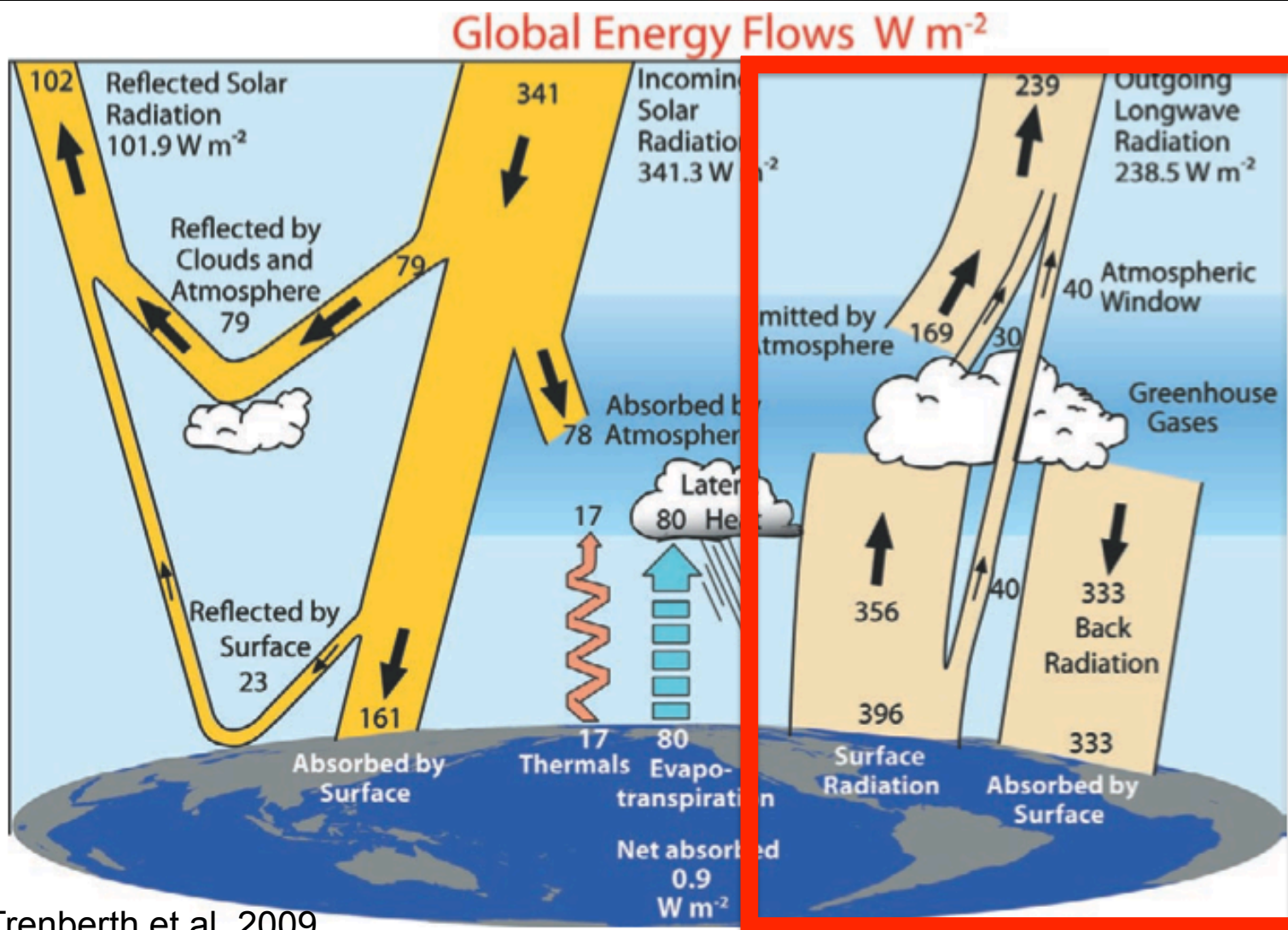


Surface Longwave Radiative Fluxes (LRF) comparisons between Surface Radiative Budget (SRB) and the CALIPSO-CloudSat-CERES-MODIS (CCCCM{C3M}) during 2006-2007

- Introduction
- Objectives and methodology
- NASA/GEWEX SRB LW & LPLA
- CALIPSO-CloudSat-CERES-MODIS (C3M)
- Zonal comparisons
- Conclusions and future work



Introduction: The Global Energy Budget



Trenberth et al. 2009



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Introduction: Uncertainties in the Downward LW Fluxes

- ✓ Importance of the Downward LW Fluxes

- ✓ Globally averaged DLF estimated: **333 – 350 Wm^{-2}**

[Trenberth et al. 2009, Kato et al. 2009, etc]

- ✓ Uncertainties in the closure of the global energy budget

- ✓ Uncertainty with in global and regional LRF assessments.

- ✓ Primary Sources of Uncertainty of DLF:

- ✓ Very sensitive to T and RH boundary layer

- ✓ Cloud properties: Height and thickness of the lowest cloud layer.

- ✓ Atmospheric Gaseous Constituents, including GHG.



Objectives and Methodology

- Assess the uncertainties and variability of long-term surface LW fluxes:
 - What is the overall uncertainty in the global annual DLF and Net LW?
 - Can the observed variability be explained?
 - Is there evidence of long-term changes that emerge above this uncertainty?
 - What is required to reduce the uncertainties in the long-term record?
- Address these objectives by:
 - Comparing currently available satellite LW flux data sets:
 - NASA/GEWEX SRB LW now spanning nearly 25 years
 - CERES and CALIPSO-CloudSat-CERES-MODIS (C3M)
 - Compare satellite and ground-base measurements using tools for various case studies.
 - Use BSRN and ARM surface measurements
 - Provide an assessment of current surface radiative fluxes retrievals including identification of needs.



NASA/GEWEX Surface Radiation Budget LW Release 3 Flux Algorithms

- Data Set Description:

The NASA/GEWEX Surface Radiation Budget (SRB) data sets contains global 3-hourly, daily, monthly/3-hourly, and monthly averages of surface and top-of-atmosphere (TOA) longwave and shortwave radiative parameters on a $1^\circ \times 1^\circ$ grid.

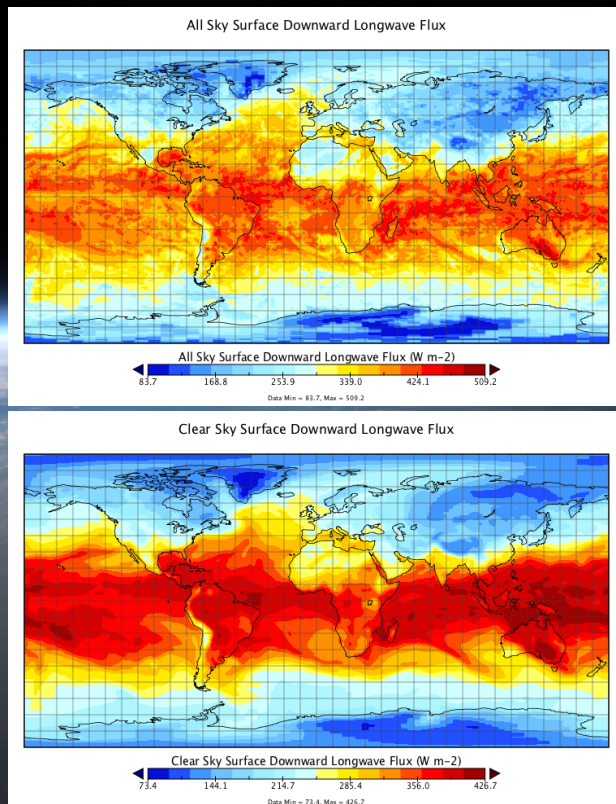
- Primary Inputs

- Visible and infrared radiances and cloud property retrievals from International Satellite Cloud Climatology Project (ISCCP DX).
- Temperature and moisture profiles from GEOS-4 reanalysis product obtained from the NASA Global Modeling and Assimilation Office (GMAO)
- Skin temperatures from GEOS-4 and/or ISCCP
- Column ozone from TOMS, TOVS, and SMOBA
- Ancillary IGBP surface vegetation and CERES surface emissivity
- Monthly CO₂ concentration values, based on monthly trend values from NOAA



NASA/GEWEX Surface Radiation Budget LW Release 3 Flux Algorithms

- LW Algorithms:



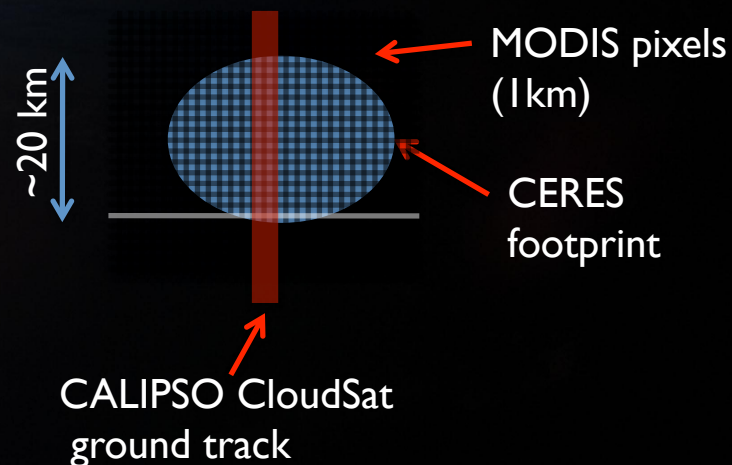
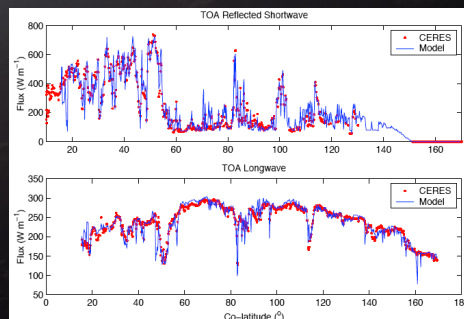
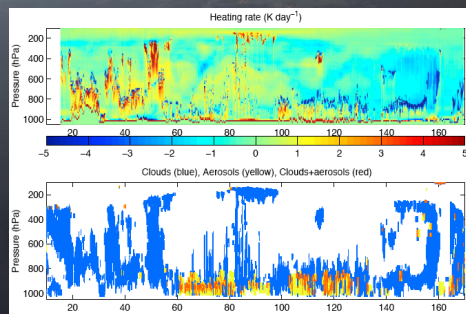
- LW algorithm is an adaptation of Fu et al., (JAS, Vol. 54, 2799-2812, 1997)
 - Uses Maximum overlap within ISCCP layers of High, Middle Low cloud classes and random overlap between those classes
- Langley Parameterized LW Algorithm – LPLA (Gupta et al) [former Quality Check].

- ~25 years of data (July 1983 through Dec 2007)



The CALIPSO-CloudSat-CERES-MODIS (CCCCM {C3M}) Data Set

1. Merged CALIPSO, CloudSat derived clouds, CERES TOA radiative flux (SW, LW, and WN), MODIS (CERES_ST) derived cloud properties both along CALIPSO-CloudSat ground-track and over the whole CERES footprint,
2. MODIS derived cloud properties by an enhanced cloud algorithm,
3. CALIPSO and MODIS derived aerosol properties
4. Vertical radiative flux profiles computed with CALIPSO, CloudSat, and MODIS derived cloud properties.
5. Uses modified Fu/Liou based algorithm (FLKRR)
 - 44 months of data (July 2006 through Feb. 2010)

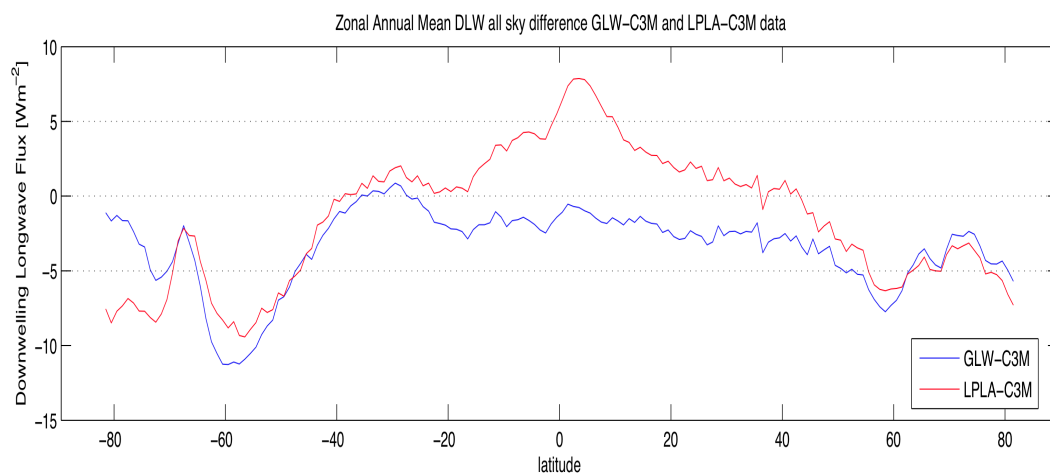
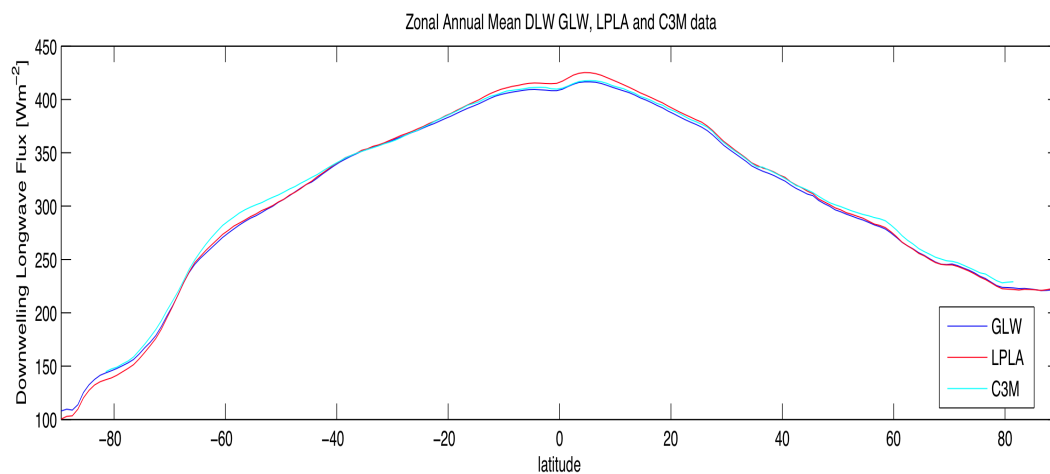


Comparisons of GEWEX SRB to CCCM LW Fluxes

- Comparison between NASA/GEWEX SRB LW & LPLA and CCCM during 12 months (January to December 2007).
 - NASA/GEWEX SRB LW & LPLA monthly averaged from 3 hourly.
 - CCCM monthly averaged from daily data files.



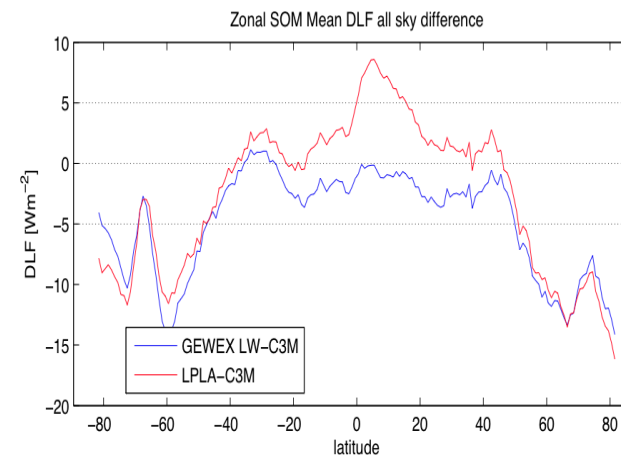
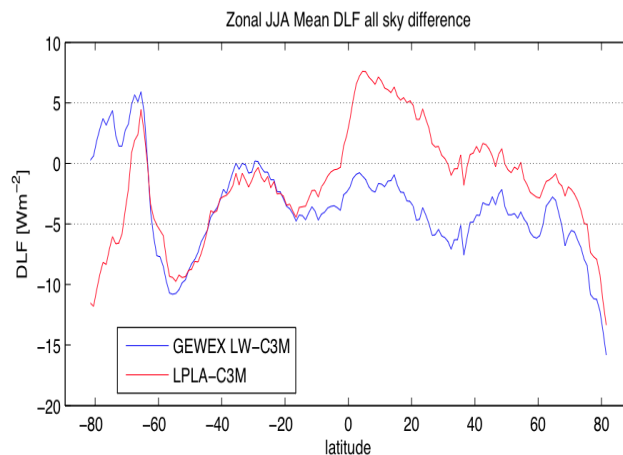
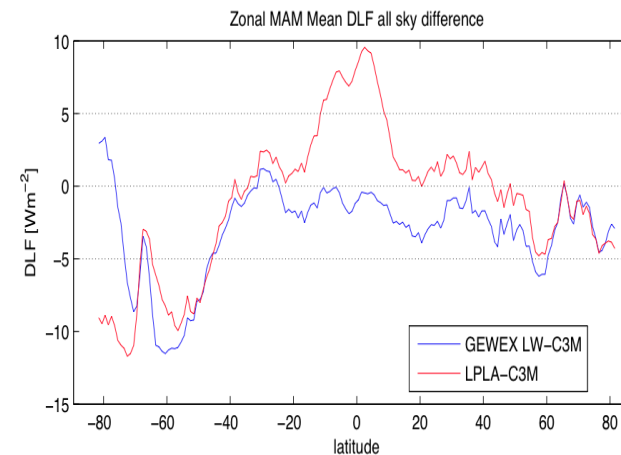
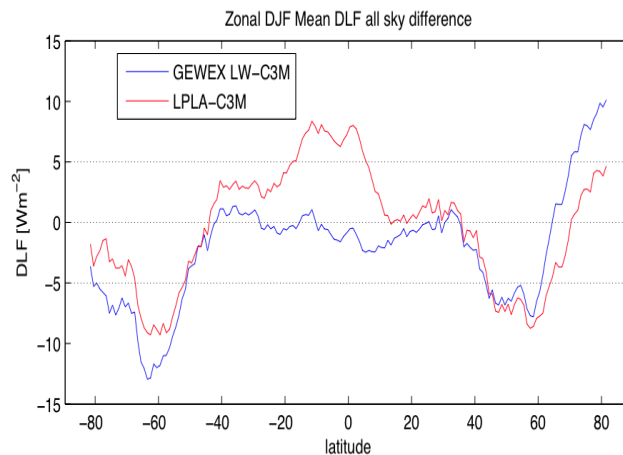
Global comparisons of Downward LW Flux



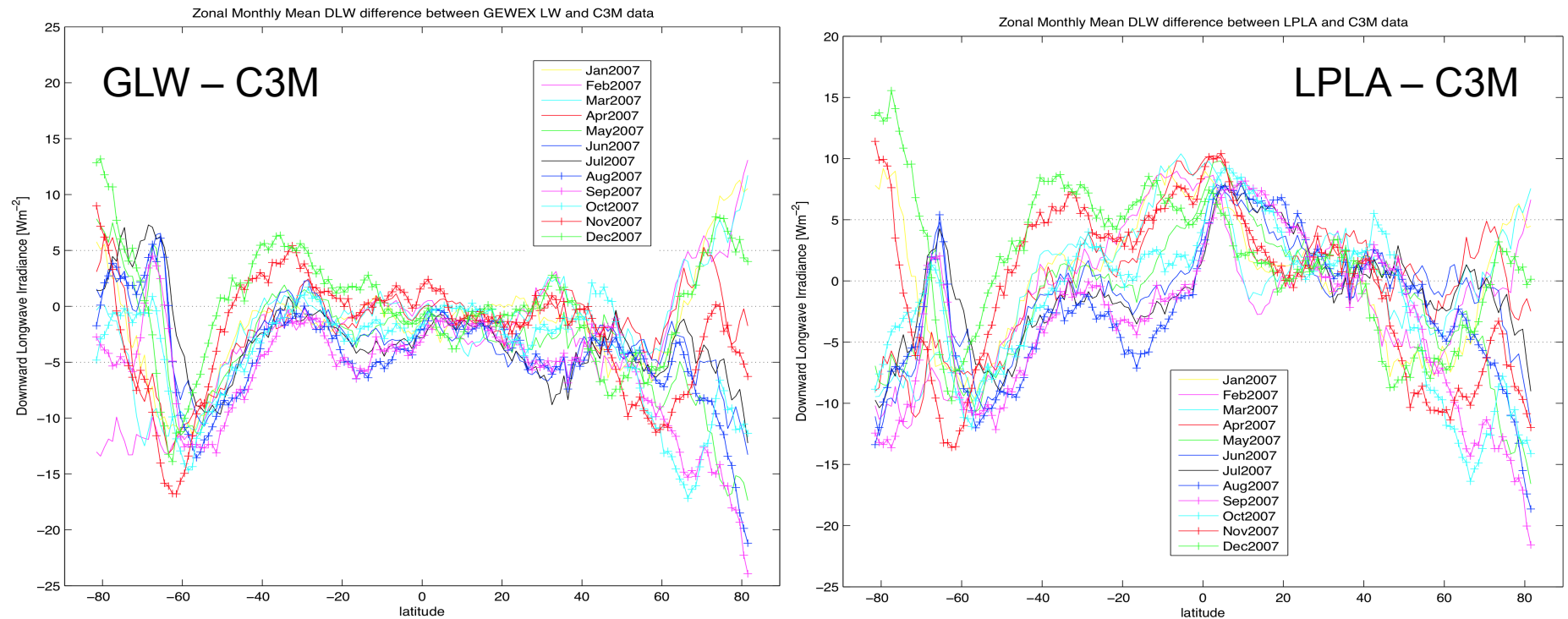
Units (Wm^{-2})	Mean	Stdev
CCCM	345.5	59.1
GEWEX/SRB	343.1	60.1
LPLA	346.0	62.3



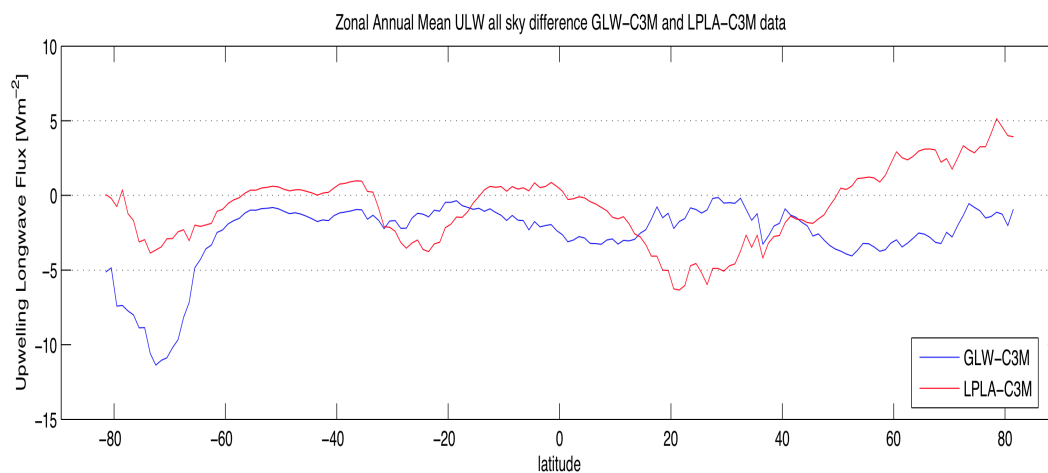
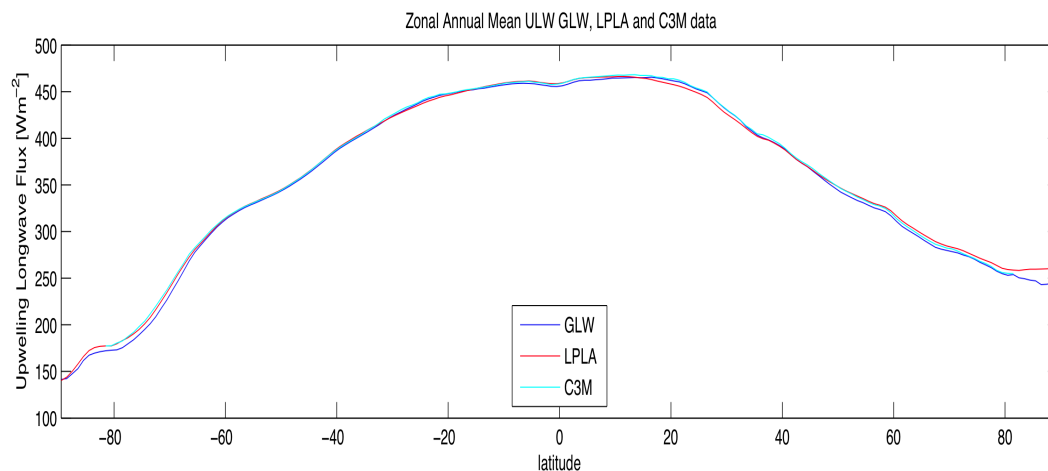
Seasonally Averaged Zonal Comparisons of GEWEX SRB and CCCM DLW Fluxes



Monthly Averaged Zonal Comparisons of GEWEX SRB and CCCM DLW Fluxes



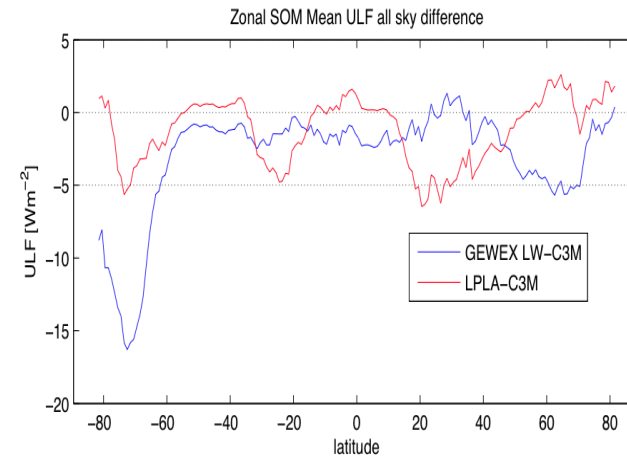
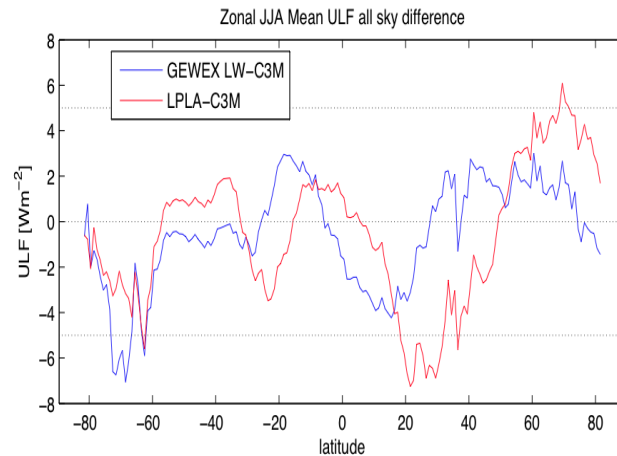
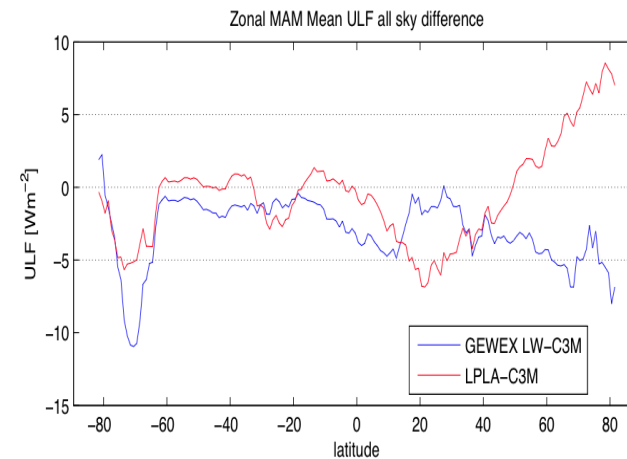
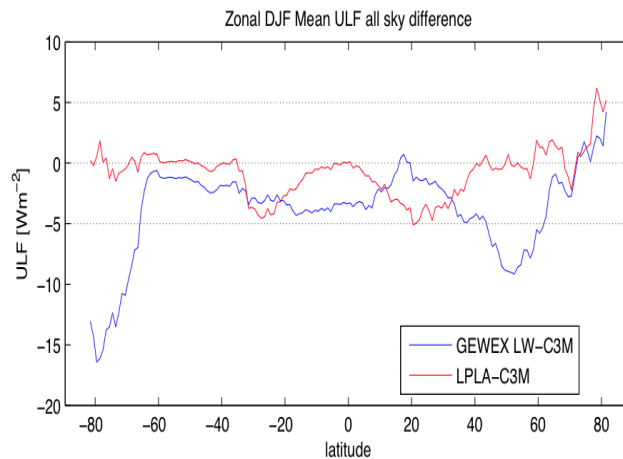
Global comparisons of GEWEX SRB and CCCM ULW Fluxes



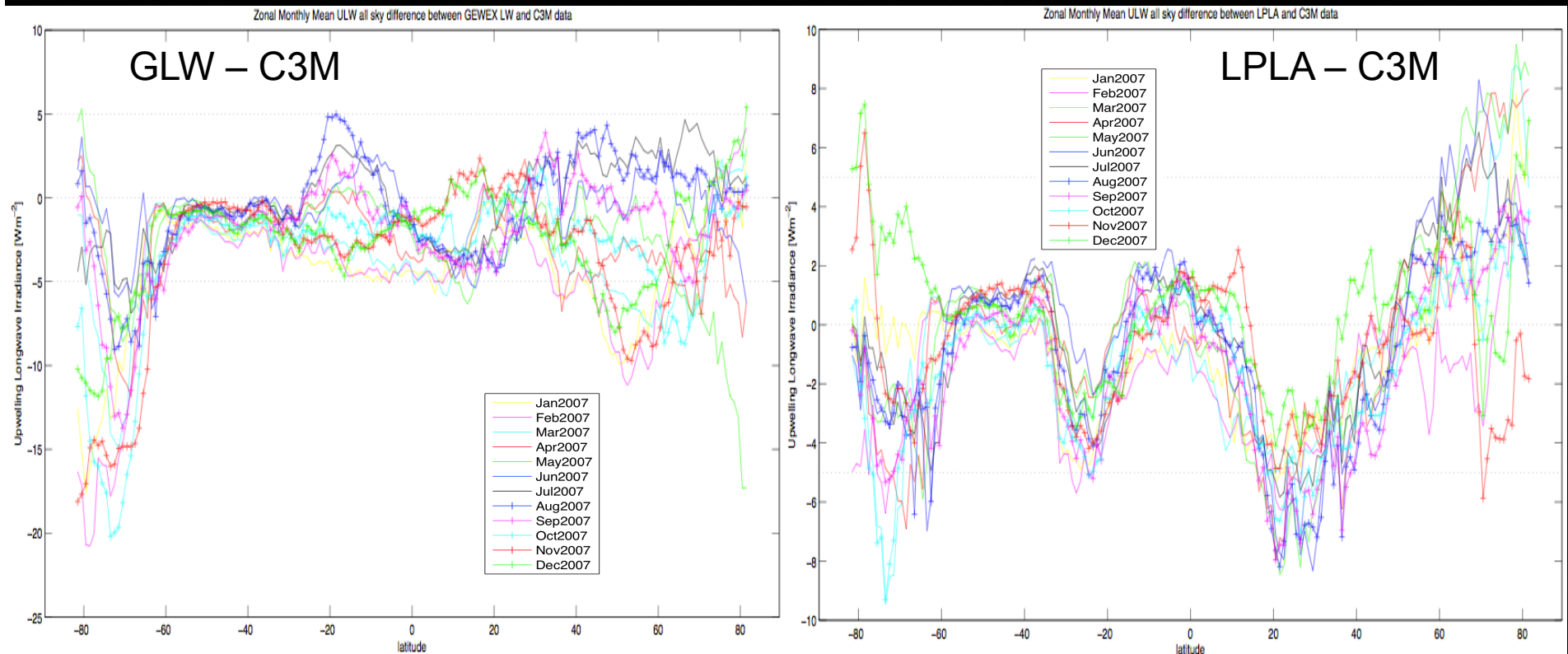
Units (Wm^{-2})	Mean	Stdev
CCCM	398.4	67.7
GEWEX/SRB	396.3	68.5
LPLA	397.2	67.8



Seasonally Averaged Zonal Comparisons of GEWEX SRB and CCCM ULW Fluxes



Monthly Averaged Zonal Comparisons of GEWEX SRB and CCCM ULW Fluxes



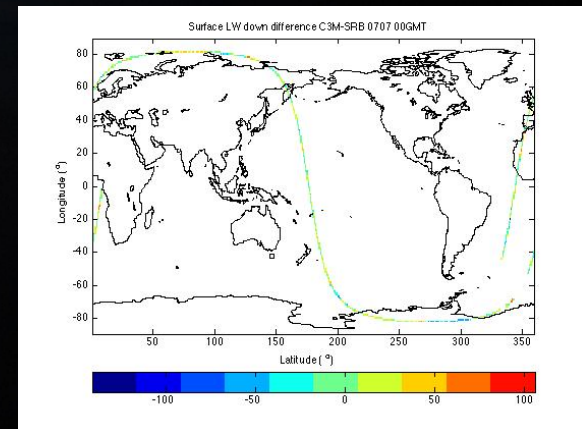
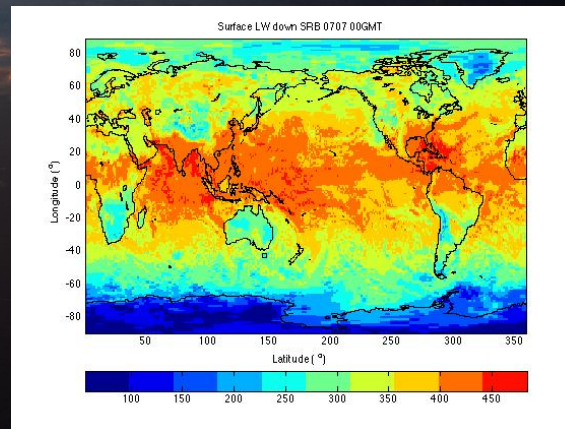
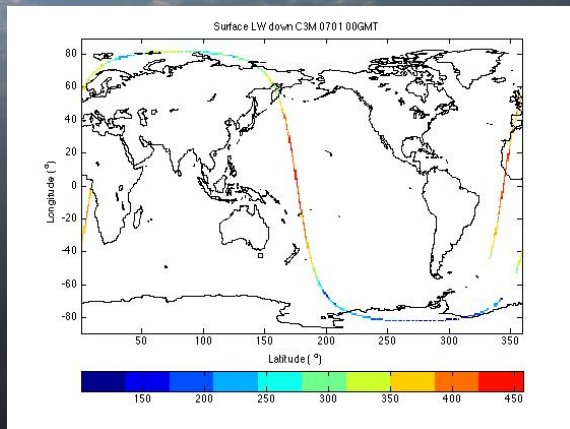
Surface Longwave Radiative Fluxes (LRF) comparisons between Surface Radiative Budget (SRB) and the CALIPSO-CloudSat-CERES-MODIS (CCCM{C3M}) during 2006-2007

- Conclusions:
 - The differences between GEWEX, LPLA and C3M are mainly at polar regions are most likely mainly due to the different cloud properties in SRB relative to CCCM.
 - Tropical differences between LPLA and C3M could be due to assumptions of cloud base that the max/random overlap assumption in GLW partially accounts for
 - The differences for the upward fluxes is in the difference in the skin temperatures.
 - GLW uses ISCCP blended with GEOS-4.
 - LPLP and CCCM use only GEOS-4; that's why they are closer.
 - More analysis is needed to assess
 - The difference between GEWEX-NASA SRB and CC3M was done based on different time base. GEWEX-NASA from 3 hourly and covering all the planet, meanwhile C3M from daily files which do not cover all the Earth's surface.



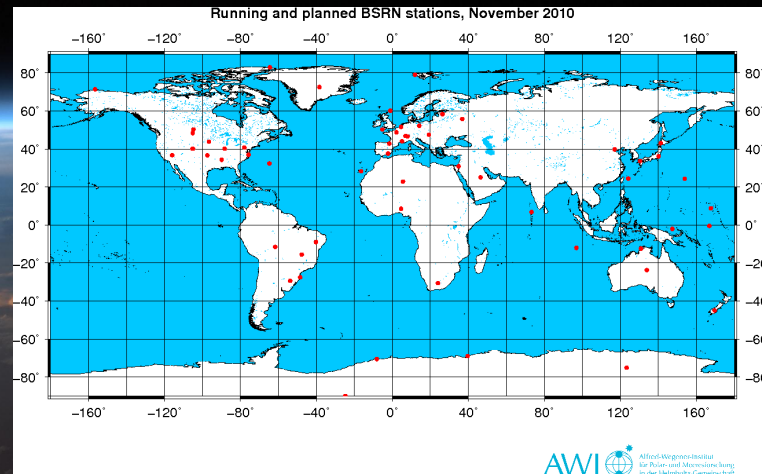
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- Future work:
 - Asses the zonal difference GEWEX/NASA SRB LW and LPLA with C3M for TOA fluxes.
 - Asses the zonal cloud properties for both databases (CF, cloud base height, cloud top height).
 - Asses the surface LW cloud radiative forcing.
 - Process and analyze CCCM data for land/ocean and day/night zonal averages and compare with 3 hourly GEWEX-SRB and LPLA LRF.



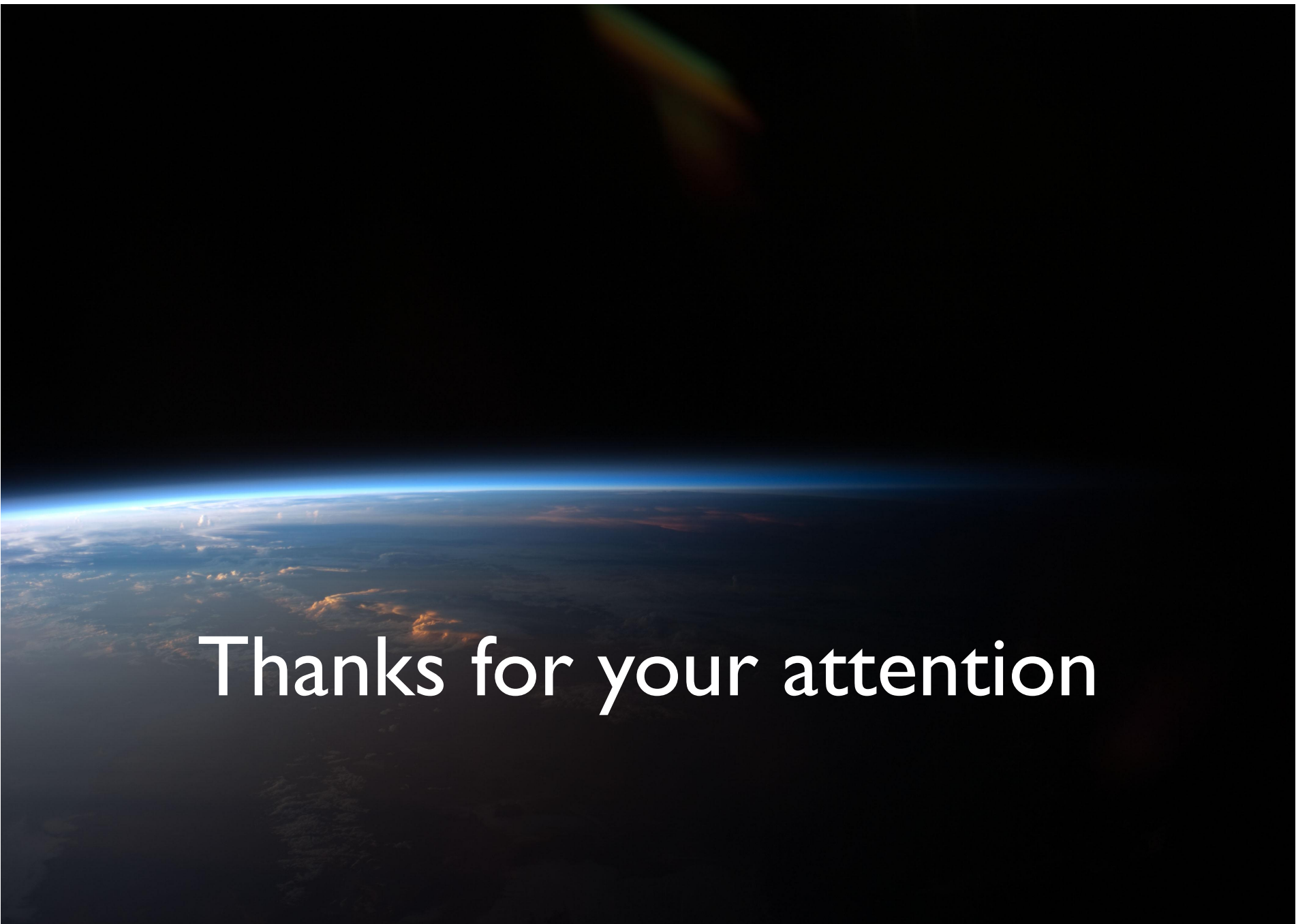
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- Future work:
 - ✓ Compare these GEWEX /NASA SRB data set with CCCM
 - assess differences and look for areas with large differences associate with surface sites



- ✓ Assemble case studies using the results of the satellite comparisons above
 - assess atmospheric trace gas, cloud and aerosol property differences relative to the downward flux
 - assess areas of greatest improvement potential





Thanks for your attention



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Extras

Surface Longwave Radiative Fluxes (LRF) comparisons between Surface Radiative Budget (SRB) and the CALIPSO-CloudSat-CERES-MODIS (CCCM{C3M}) during 2006-2007

- NASA/GEWEX SRB LW & LPLA (cont.)
 - The release 3.0 version includes:
 - Improved cloud properties in areas in missing and sun glint regions where ISCCP cloud retrievals aren't performed.
 - The IR radiative parameterization of ice clouds has been updated (Fu et al. 1998).
 - Update water vapor continuum (Kratz and Rose, 1999).
 - An error in the ozone profile assignment is corrected.
 - The surface vegetation type maps updated, affecting the surface emissivity values (Rutan et al. 2009).
 - Monthly CO₂ concentration values, based on monthly trend values



Surface Longwave Radiative Fluxes (LRF) comparisons between Surface Radiative Budget (SRB) and the CALIPSO-CloudSat-CERES-MODIS (CCCM{C3M}) during 2006-2007

- CCCM (CALIPSO-CloudSat-CERES-MODIS)

Funded by the NASA Energy Water Cycle Study (NEWS) project.

Provide a global data set along the lidar/radar ground track with the most accurate and comprehensive aerosol properties, cloud properties, and vertical radiative flux profiles.

Improvement in different study areas:

- ✓ Assimilation and prediction by global aerosol models through better understanding of aerosol layer location.
- ✓ Understanding of multi-layered and polar cloud systems and their radiative impacts.
- ✓ Better understanding of frequency of occurrence of thin cirrus and boundary layer clouds and their radiative impacts
- ✓ Error assessment of cloud and aerosol properties derived from passive instruments and irradiances computed with them
- ✓ Better estimate of surface and atmospheric radiation budget

